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SCE HIGH PENETRATION SOLAR PV

CURRENT STATUS AND RESEARCH

SCE Service Territory

Overview

- 5 million customer accounts
- 2012 peak load: 21996 MW
- 50,000 mi² service territory
- Large solar potential

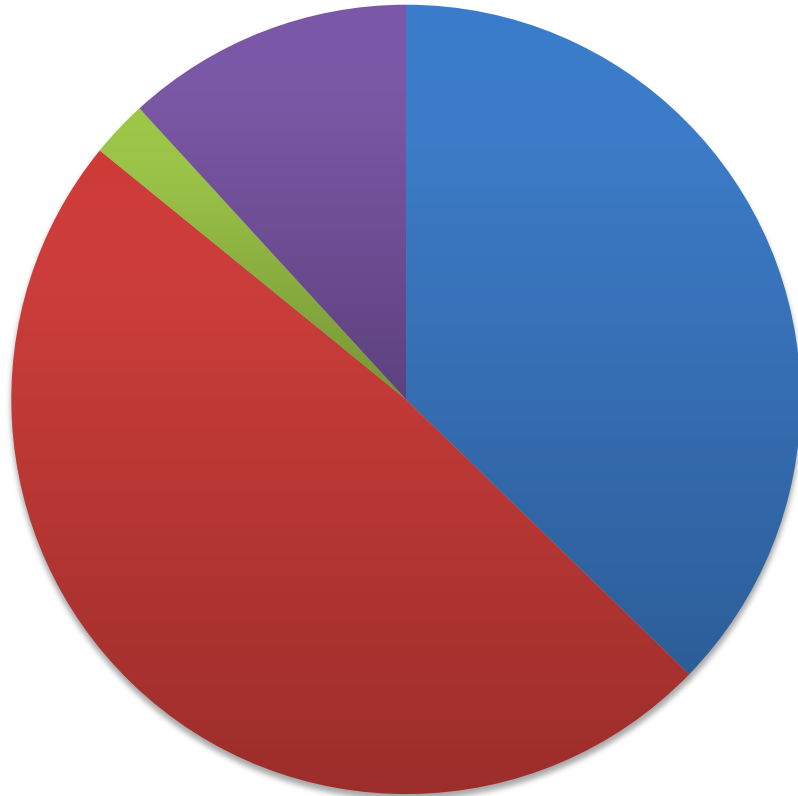


Distribution Infrastructure

- 810 distribution substations
- 4,350 distribution circuits
- 103,000 circuit miles
- 713,000 OH & UG distribution transformers
- 60,000 switches
- 13,000 capacitor banks
- 26,000 relays
- 7,000 circuit breakers

SCE Interconnected Distributed Solar PV*

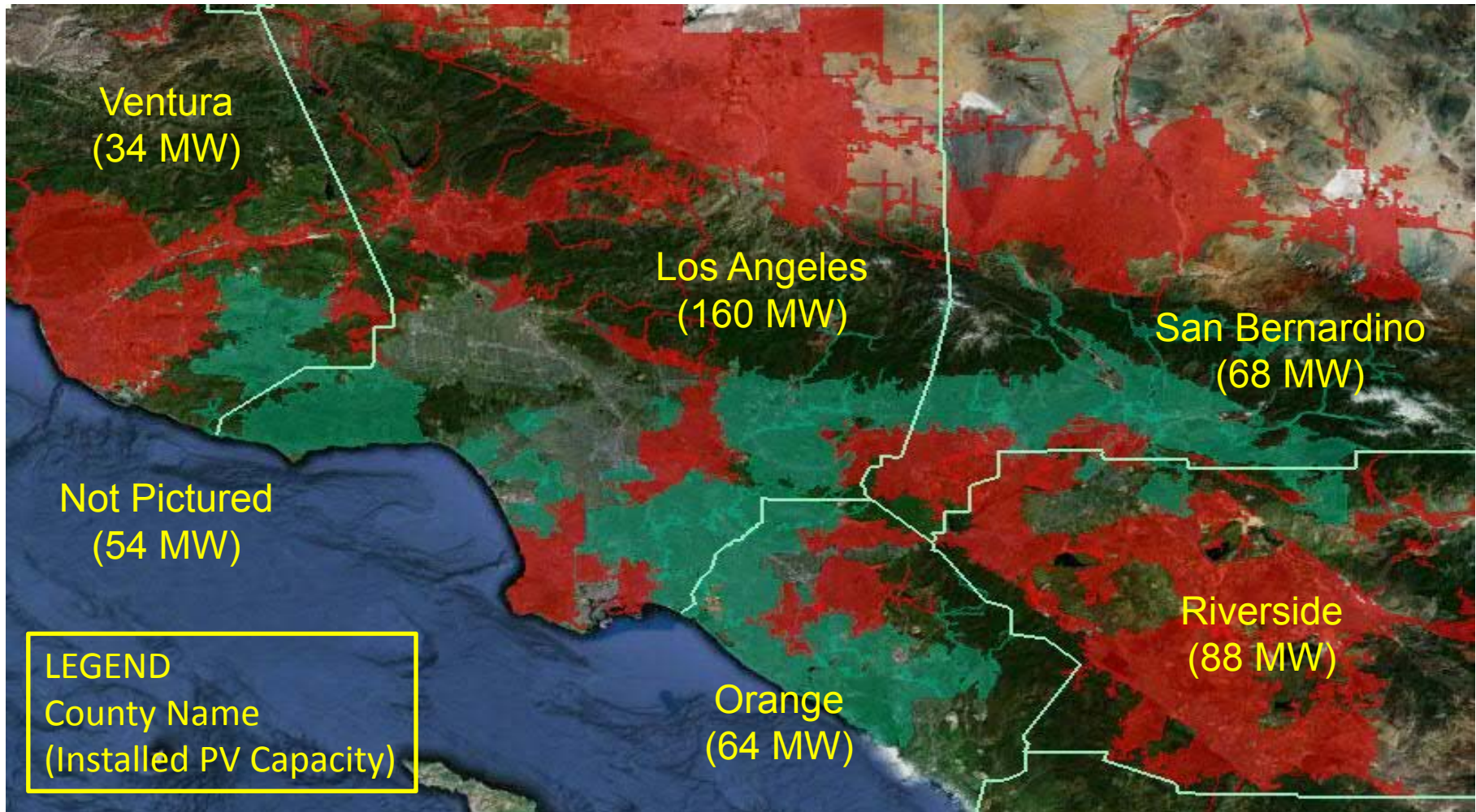
Interconnected Distributed PV



- Residential: 199 MW
- Comm. & Ind.: 259 MW
- Agricultural: 13 MW
- Utility Owned: 63 MW
- Total PV: 534 MW
- Total NEM: 463 MW
- Avg. Residential NEM Size: 4.76 kW

* As of 12/31/12

SCE Preferred Interconnections & Installed PV



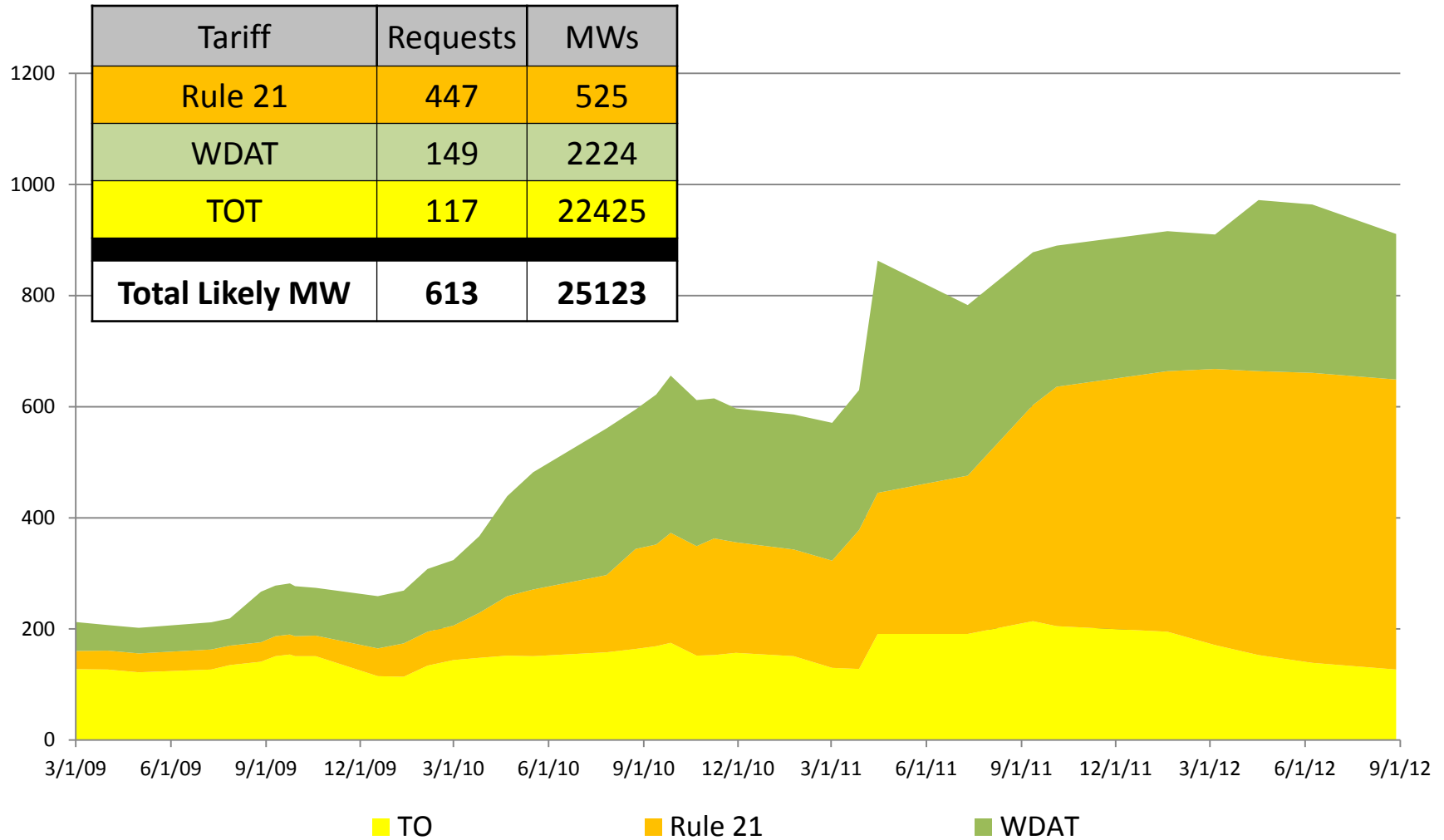
*Sub-transmission network level view available at www.sce.com

Preferred Not Preferred

Rule 21 Proceedings

- Phase 1
 - > Significant progress in Rule 21 process
 - > Revised Rule 21 will improve the interconnection process for all developers, particularly solar
 - > Encourage developers to utilize pre-application process as well as the SCE interconnection maps when siting new projects
- Phase 2 (in progress)
 - > Support additional improvements in the interconnection process
 - Distribution Group Study process will provide a more efficient study process and provides more equitable cost sharing among generators

Number of SCE's Active Interconnection Requests



Increasing Solar PV (Engineering)

- More Information
 - > Lack of validated models (SC, harmonics, load flow)
 - > Monitoring
 - Remote switching with high levels of DER and little information
- More Control
 - > Use of resources to optimize voltage and VAR control
- Safety
 - > Transient over-voltages created when interrupting DER
 - > Anti-islanding performance with multiple DER and lightly loaded lines
- Power quality
 - > Low Voltage Ride Through/Harmonics/Transient over-voltages

Increasing Solar PV (Financial)

- Customer costs
 - > NEM creates a cross-subsidy where non-solar customers pay for solar customers' infrastructure costs
 - > High barrier cost of entry still exists although new financing options available
- Societal & utility costs
 - > Larger generation tends to interconnect in rural areas where land is cheaper, but interconnection costs are higher
 - > Some distribution circuits must be reconfigured to accept higher levels of PV

Current Research for Distributed Solar PV

- Collaborative efforts
 - > Alternatives to the 15% Rule (EPRI)
 - > Utility Scale Solar Forecasting (EnerNex/UCSD)
 - > High-Penetration PV Integration (NREL)
 - > Distribution Monitoring of Renewables Integration (CIEE)
- Internal research areas
 - > SCE Inverter Testing
 - > SCE Transient Monitoring of Solar PV Plants
- Still have additional data needs
 - > Higher sampling, meters spread over distribution circuits to observe interactive effects of smaller sites

Future Research for Distributed Solar PV

- Distribution model for SCE territory
 - > Develop and validate a model that will generate end-use (meter level) and aggregate (feeder level) load curves representative of all geographic and socioeconomic regions
 - > Apply various technology (PV, Storage, EE, etc) adoption scenarios to the model to understand system effects
- Evaluate and demonstrate optimal distribution grid
 - > Coordinated rules for customers to optimize use of resources and loads
 - > Maximize efficiency and security by enabling flexible and secure use of resources/loads driven by market signals rather than regulatory process

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Q & A AND DISCUSSION